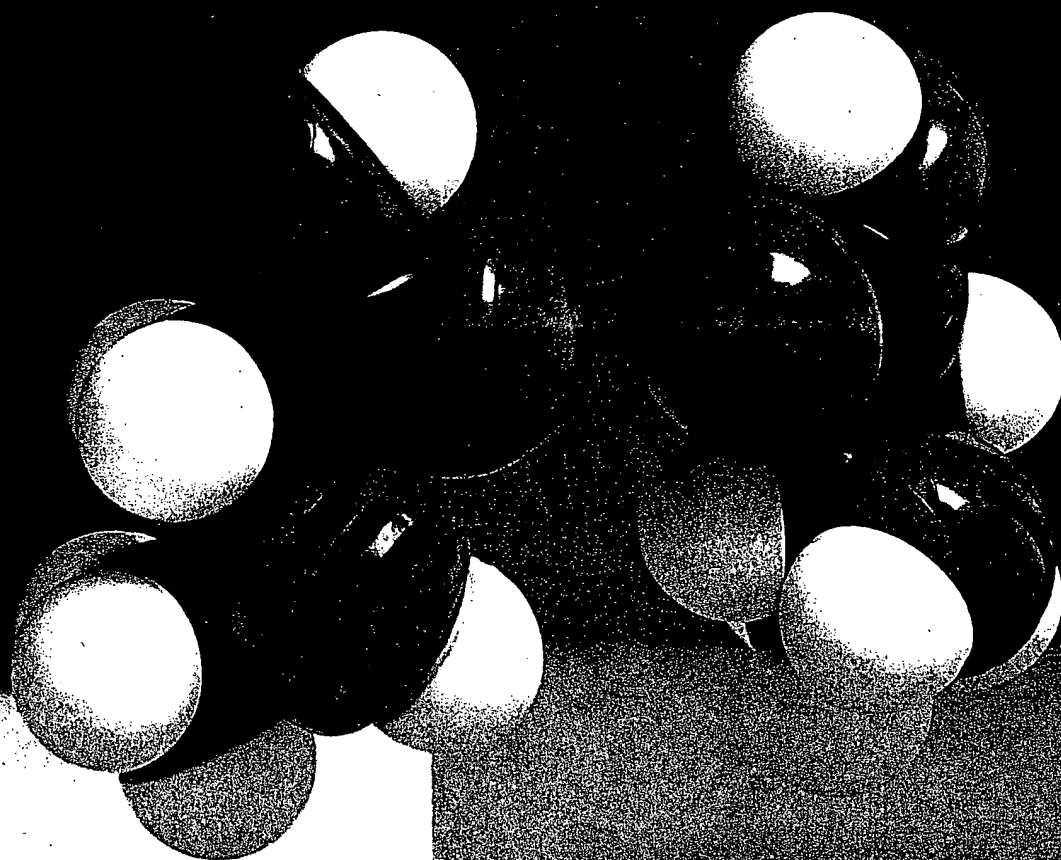


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# INTRODUCTION TO ORGANIC CHEMISTRY

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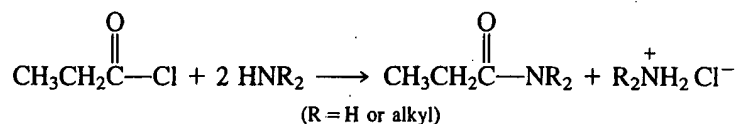
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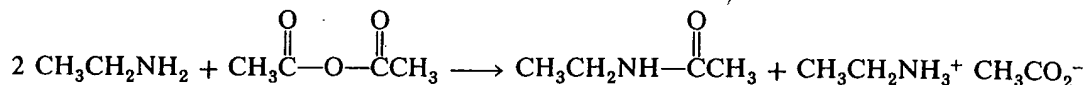
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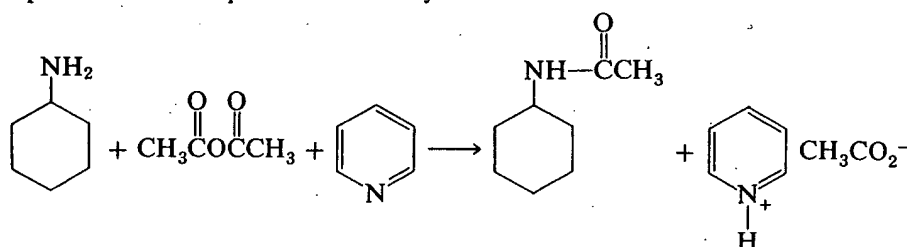
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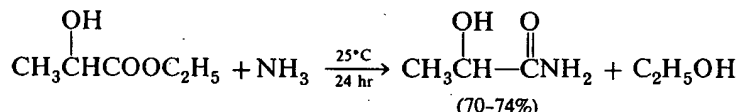
The reaction of ammonia and amines with anhydrides follows a similar course; the products are 1 mole of amide and 1 mole of carboxylic acid. Since the liberated acid reacts to form a salt with the ammonia or the amine, it is necessary to employ an excess of that reactant.



As in the analogous reaction of amines with acyl halides, one may carry out the reaction in the presence of one equivalent of tertiary amine.



Esters also react with ammonia and amines to yield the corresponding amide and the alcohol of the ester. This synthetic path is useful in cases where the corresponding acyl halide or anhydride is unstable or not easily available. An interesting example of such a case is

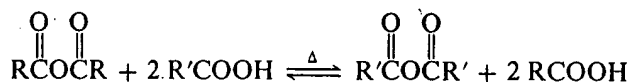


In this case the acyl halide method for preparing the amide may not be used, since the molecule contains an OH group, which will react rapidly with an acyl halide.

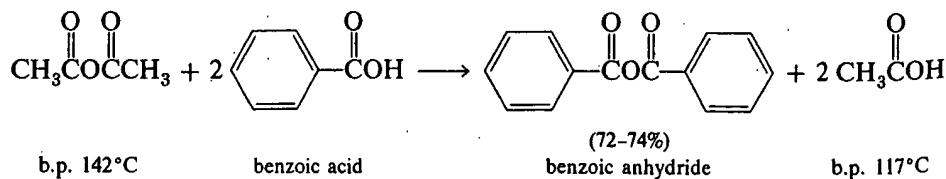
**EXERCISE 19.7** Treatment of 2-hydroxypropanoic acid (lactic acid) with thionyl chloride gives a product having the formula C<sub>6</sub>H<sub>8</sub>O<sub>4</sub>. Propose a structure for this material.

### C. Reaction of Acyl Halides and Anhydrides with Carboxylic Acids and Carboxylate Salts. Synthesis of Anhydrides

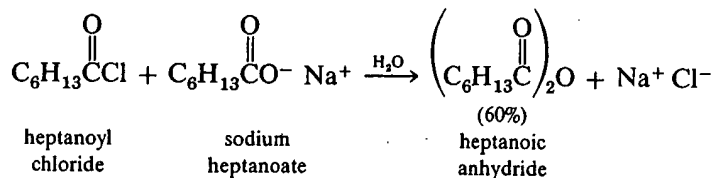
A mixture of an acid anhydride and a carboxylic acid undergoes equilibration when heated.



The reaction is preparatively useful when the anhydride is acetic anhydride. In this case, acetic acid can be removed by distillation as it is formed because it is the most volatile component in the equilibrium mixture.

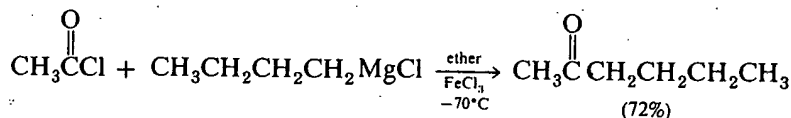
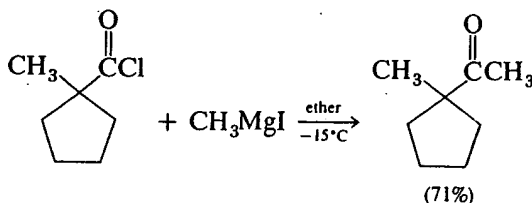


The only carboxylic acid derivatives that undergo a useful reaction with carboxylate salts are acyl halides. The product is an anhydride.

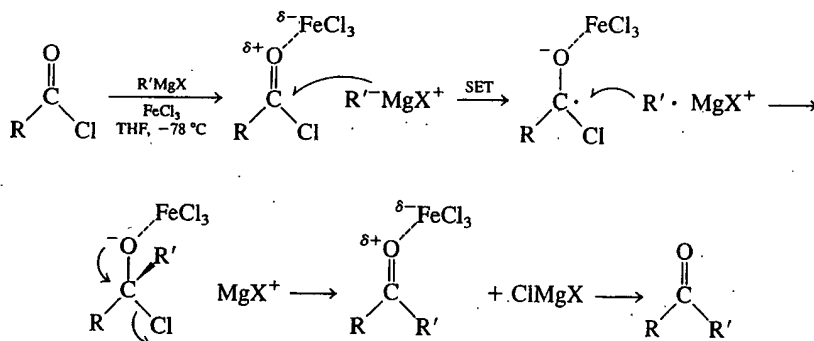


#### D. Reaction with Organometallic Compounds

Acyl halides react with various organometallic reagents to give ketones. Since ketones are also reactive towards many of the reagents, it is best to use less reactive agents when the target compound is the ketone. Reaction with a Grignard reagent can give ketones if the reaction is carried out at low temperature and the Grignard reagent solution is added to the acyl halide to avoid further reaction of the ketone to form tertiary alcohol. Anhydrous ferric chloride is often added as a catalyst.



Ferric chloride may serve as a Lewis acid, complexing with the oxygen of the acyl chloride. Many organometallic reactions are now thought to proceed by **single electron transfer (SET)**. The carbanion of the Grignard transfers an electron to the acyl chloride–ferric chloride complex to yield a stabilized radical anion and a highly reactive alkyl radical. The radical then combines with the radical anion to form the “tetrahedral intermediate” familiar from our discussion of hydrolysis. The intermediate decomposes to yield the ketone, magnesium halide and the catalyst ferric chloride.



(See Sections 8.6 and 8.8.) Rapid reaction at low temperatures is consistent with an SET mechanism.

If excess Grignard reagent is used the product ketone reacts further, giving a tertiary alcohol.